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ASO Contamination Control Manual

Astrotech Space Operations, Inc. (ASO)

ASTROTECH®

A SPACEHAB COMPANY

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KEY DEFINITIONS

Airborne Particulate Matter – Particulate matter suspended in the ambient atmosphere.

Air Lock – Area between the clean room and the outside environment. The air lock receives the same clean, filtered air as the clean room and is designed to prevent contaminated air in the outside area from flowing into the clean room.

Ambient – Surrounding on all sides.

Class 10,000 – Per FED-STD-209, no more than 10,000 particles of the 0.5 micron size nor no more than 70 particles of 5.0 micron or larger is permitted per cubic foot of air.

Class 100,000 – Per FED-STD-209, no more than 100,000 particles of the 0.5 micron size nor no more than 700 particles of 5.0 micron or larger is permitted per cubic foot of air.

Cleanliness Level – Established maximum allowable distribution of contamination [particulate and/or Non-Volatile Residue (NVR)] of a given size or quantity in a stipulated area or volume.

Contaminant – Molecular and or particulate matter that is present in specified environment that shall affect or degrade the performance of the components upon which they reside.

Contamination – Presence of one or more unwanted contaminants in or on the surface being protected which could affect or degrade the performance of the component.

Controlled Areas – Clean rooms and areas designed to protect hardware from contamination by procedurally controlling the air cleanliness, temperature, humidity, and personnel activities.

Critical Surface – Any surface sensitive to contamination and required to meet the specified cleanliness condition.

Exterior Surfaces – All flight hardware surfaces that are normally exposed directly to the processing facility environment.

Fibers – Particles longer than 100 micron with a length to width ratio of more than 10:1.

Flushing – Method of cleaning surfaces with a stream of filtered solvent, under pressure, directed against a surface to dislodge and flush away any foreign material.

Gross Cleaning – Cleaning operation to achieve a level of product cleanliness as part of good workmanship and housekeeping practice; for example, the removal of oils, grease, oxide films, etc during facility installation of new items. Gross cleaning does *not* require verification beyond visual inspection with normal corrected vision. For spacecraft delivery containers, gross cleaning would consist of pressure wash of the exterior surface with water to remove excessive dust and wiping of the exterior surfaces before entry into air lock.

High Efficiency Particulate Air (HEPA) – Filter with minimum efficiency of 99.7 percent determined by the ambient air test method of air flows of 20 and 100 percent of the rated flow capacity of the filter. Particles 0.3 micron and larger are removed from the air stream.

Micron – Unit of measurement equal to one-millionth of a meter or thirty-nine millionth of an inch and denoted by the symbol "□". (25□ is approximately 0.001 inch.).

Non-Volatile Residue (NVR) – The soluble or suspended material remaining following the filtration and evaporation of rinse solvent at a specified temperature.

Outgassing – Release of volatile components of a material in ambient conditions.

Particle Size – Expressed as the apparent maximum linear dimension or diameter of the particle in microns.

Particulate Fallout – Particulate matter that settles out of the air onto a horizontal surface.

Visibly Clean (VC) – Absence of all particulate and non-particulate matter visible to the normal, unaided eye (except correction for vision), using normal room lighting.

Volatile Condensable Residue – Material which is released by the process of outgassing and is able to condense on other surfaces.

Wiping – Cleaning of a surface with a wipe dampened with detergent or solvent.

Witness Plate – Solvent resistant surface used for the collection of particulate fallout and NVR.

ACRONYMS AND ABBREVIATIONS

ASO	Astrotech Space Operations, Inc.
ASTM	American Society for Testing and Materials
DM H20	Demineralized Water
FED	Federal
GSE	Ground Support Equipment
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
IPA	Isopropyl Alcohol
KSC	Kennedy Space Center
LN2	Liquid Nitrogen
MIL	Military
MSDS	Material Safety Data Sheet
NVR	Non-Volatile Residue
S/C	Spacecraft
STD	Standard
VAFB	Vandenberg Air Force Base
VC	Visibly Clean

1. SCOPE

This manual defines the process to be implemented for the control of contamination within the garment room, high bays, encapsulation bays, air locks, control rooms, and low bays at the Astrotech facilities located in Vandenberg Air Force Base (VAFB), California; Titusville, Florida; and Sea Launch in Long Beach, California. The manual identifies the control areas, the contamination control system, personnel compliance requirements, and organization responsibilities.

This manual supplements the corresponding Astrotech Facility Accommodations handbooks, which provide more complete descriptions of the sites and clean room locations.

2. REFERENCED DOCUMENTS

The following documents provide specifications and guidance for the establishment, test, and operation of cleanrooms and thus forms a part of this manual as applicable. This manual will supersede the cleaning requirements of any referenced documents.

ASTM E1234-88	Handling, Transporting and Installing Non-Volatile Residue (NVR) Sample Plates Used in Environmentally Controlled Areas for Spacecraft
ASTM F312-69	Standard Methods for Microscopic Sizing and Counting Particles from Aerospace Fluids on Membrane Filters
ASTM F50-83	Continuous Sizing and Counting of Airborne Dust Particles in Dust Controlled Areas Using Instruments Based Upon Light Scattering Principles
FED-STD-209	Clean Room and Work Station Requirements, Controlled Environment
KSC-P-0015	Specification for Minimum Requirements for Garments Used in Clean Room Environments for Hazardous Operations
MIL-STD-1246	Product Cleanliness Levels and Contamination Control Program
SN-C-0005	Contamination Control Requirements for the Space Shuttle Program, Specification

3. RESPONSIBILITIES

3.1 GENERAL

It is the responsibility of all personnel using the controlled and adjoining areas of the Astrotech facilities to comply with the requirements of this manual. In addition, it is the responsibility of the visitor escorts to ensure visitor compliance.

3.2 ASTROTECH

Astrotech Space Operations, Inc., (ASO) will:

- Operate the controlled areas in accordance with the baselines established by this manual.
- Monitor compliance with the established rules and take corrective action as required.

- Inform users and visitors of the clean areas and appropriate contamination control procedures.
- Mitigate conflicts in control plans when the areas are being occupied by more than one user.
- Set up and monitor facility devices that record temperature, humidity, and particulate.
- Report any deviation from user mission specific established monitoring parameters.

3.3 USER/TENANT

Each user/tenant of the facility will:

- Define and communicate the appropriate specific program contamination control procedures.
- Provide a restricted materials list.
- Provide specialized sampling and/or cleaning materials.
- Implement and monitor personnel compliance with the appropriate procedures.
- Verify and determine the acceptability of monitoring data.
- Establish the applicable visitor access and escort requirements.
- Maintain workbench and clean area cleanliness.

4. FACILITY DISCUSSIONS

Class 100,000 is maintainable by following general housekeeping practices regarding cleaning, personnel discipline, and facility utilization. The clean areas will be monitored for compliance. Class 10,000 and/or program specific Non-Volatile Residue (NVR) levels have been achieved by enacting and maintaining additional personnel and cleaning discipline.

4.1 GENERIC CLEANING GUIDELINES

The facility cleaning activities can be separated into the initial activation of the clean room area and the recurrent cleaning between different users.

4.1.1 Initial Pre-Occupancy Cleaning

The processing areas will undergo a complete top to bottom area cleaning with detergent solution and vacuum as necessary to remove any oils, solvents, debris, etc., following construction completion. Once the gross cleaning has been completed, the floor will be vacuumed with a High Efficiency Particulate Air (HEPA) filtered vacuum or a vacuum that exhausts outside of the clean area and scrubbed with detergent solution.

The clean area will then be ready for activation wipe/mopping with an Isopropyl Alcohol (IPA)/H2O solution. The wipe down shall be performed in the following order:

1. ceiling, recessed lighting, and horizontal fixtures;
2. crane and rollup doors;
3. all other horizontal walls, access doors, and surfaces; and
4. floor.

4.1.2 Recurrent Cleaning

- Facility areas will be cleaned, monitored, and verified to be Class 100,000 before arrival of spacecraft hardware.
- Entire clean area will *not* be re-wiped unless excessive contamination is evident or if major repair activity has occurred since the activation cleaning.
- HEPA filtered vacuum cleaner or vacuum that exhausts outside of the clean area will be utilized in the clean areas.
- Vertical surfaces up to a height of 10 feet shall be cleaned top to bottom and wiped/mopped in one uniform direction.
- Floor will, at a minimum, be damped mopped. In most cases, a floor machine will be utilized to scrub the floor between spacecraft programs.
- Air shower (even if *not* activated) will be vacuumed and wiped down.
- Trash and fire retardant receptacles in all areas when occupied by the user will be emptied once per normal scheduled work day..

4.1.3 Cleaning and Purging Chemicals

- Material Safety Data Sheets (MSDSs) will be required for each chemical to be used in the clean room areas.
- Flammable solvents will be stored in provided flammable lockers.
- Polyethylene or Teflon bottles and/or metal plunger cans shall be utilized to dispense solvents and/or detergents in the clean areas.
- Maximum container quantity stored in the clean area locker should *not* exceed one gallon.
- Containers will be unpackaged outside of the clean area and visually inspected prior to movement into the clean area.

4.1.3.1 Alcohol

IPA conforming to specification TT-I-735 diluted a minimum of 4:1 with water will be utilized for routine weekly mopping of the clean room areas, unless an alternate mopping solution is specified and provided by the program user. No more than five gallons of the mopping solution shall be transported into the clean areas. The solution will be changed after mopping any 2,400 square foot floor or when visibly dirty.

More concentrated IPA (up to 99 percent) or ethyl alcohol may be utilized to wipe hardware surfaces and should be dispensed from appropriate containers. All IPA/H2O wipes will be placed in flame retardant cans after use.

4.1.3.2 Water

Facility water will be utilized to wash out the fueling island trench as required. Facility or demineralized water (DM H2O) may be utilized to dilute the IPA concentration.

4.1.3.3 Detergent

The floors may require use of industrial type detergents to remove soil. The acceptability of the detergents will be verified with the user contamination control personnel prior to use. No more than five gallons of a pre-mixed detergent solution shall be transported into the clean work areas at any given time. The solution will be changed after mopping a 2,400 square foot area or when visibly dirty.

4.1.3.4 Purge Gases

Certain spacecraft instruments, particularly optical units, are sensitive to both molecular and particulate contamination and will require purge with inert gas to limit the particulate fallout on and around protective covers. The boil off from the highest grade of liquid nitrogen (LN2) provides the optimum purge protection and should be utilized whenever possible. All purges will remain intact as late as possible.

Gas k-bottles are to be secured upright and a regulator utilized to distribute gases. Gas vents should occur in a controlled manner and be directed into the facility exhaust ports whenever possible.

4.2 PERSONNEL CONSIDERATIONS

Personnel experiencing cold symptoms, excessive coughing or sneezing, or severe flaking due to sunburn are *not* allowed in the clean room. Personnel shall never wear or apply cosmetics or perfume or perform personal hygiene while in the clean room. No food, drink, chewing gum, or tobacco is allowed in the clean areas.

All personnel shall be informed of the appropriate clean area garment requirements and procedures before being given the access code or being escorted into the clean area.

4.2.1 Man Loads

The controlled area man load should be maintained whenever moving equipment into or from the processing area. User procedures may further restrict access during specific operations. Nonessential personnel will be asked to leave the area if the cleanliness level approaches the upper limit.

4.2.2 Garments

Clean room garments at a minimum shall consist of smocks or coveralls and shoes, either street shoes with covers or clean room shoes. The smocks shall be clean, lint-free, and anti-static.

Head coverings if required should be such that no hair shall be visible outside the cap. Face masks or beard covers are normally *not* required.

A set of clean room coveralls if properly maintained can be worn by the same person for the entire processing period as long as the garments do *not* become soiled. Soiled garments shall be laundered prior to reuse. Garment donning should be performed in the following order: head, body, foot, and then hands. Clean room garments should *not* be worn outside of the garment change room or clean areas. Once removed from the bag, clean room garments must be hung on a hanger in the garment room, bagged and placed in the provided lockers, or rebagged and sealed before removal from the garment room. The garments may *not* be reused if they become damaged (loose fasteners or tears).

Gloves, if utilized, should be placed over the ends of the garment cuffs. Gloves should never touch any part of the face. If gloves become soiled or torn, move away from the flight hardware and change

gloves. Care shall be taken when selecting and wearing gloves to ensure that powder or other airborne contaminants are minimized.

With ordnance or hazardous materials present, personnel shall wear approved non-static producing, flame retardant clean room garments.

4.2.3 Access

Cipher lock or card reader entry doors are provided to control personnel access to restricted and/or clean areas. The user will provide appropriate personnel with the entry access codes. Personnel limits may be established to control the number of personnel in the clean areas.

4.3 CONTROLLED AREAS DESIGN AND OPERATING INFORMATION

Astrotech clean areas involved with contamination control consist of the garment change room, the air lock, processing high bay, and encapsulation bays. Facility control rooms may periodically be utilized to move electrical racks into the processing areas; however, exterior control room doors leading to the outside must remain closed to reduce contamination risks.

4.3.1 Thermal Conditions/Monitoring/Environmental Requirements

Environmental requirements and monitoring thereof are applicable when the facility is being readied for flight hardware arrival, staging, and processing. The thermal conditions in the facility may be relaxed during periods of non-occupancy in accordance with energy conservation initiatives. The user may request modification to thermal conditions during certain testing periods and is responsible for alerting personnel to appropriate contamination measures during these periods.

A computer-based monitoring system controls the area thermal conditions. The system displays real time readout of area status and has alarm preset points to alert personnel of trouble conditions (both low and high settings).

Control areas are to utilize HEPA filters. Control area pre-filters shall be inspected quarterly and HEPA filters will be inspected annually. Each HEPA should be tested every five years to verify pressure drop across the filter face. Pitot tubes are installed on all panels of HEPA units to perform the measurements. Facility air conditioning systems are designed to ensure three to four room exchanges per hour.

4.3.2 Facility Maintenance/Repair

Facility maintenance and repair shall be scheduled to minimize contamination issues and concerns. No exhaust fumes or chemical spraying will be allowed within 50 feet of the air intakes when spacecraft hardware is being staged or processed. Roofing repair materials, all lubricants and solvents must be coordinated with the user to ensure that the materials do *not* pose any Non-Volatile Residue (NVR) contamination concerns.

All facility-provided clean room equipment, such as electric forklifts, monitoring devices, HEPA filtered vacuum, etc., will remain in the clean areas when possible. Equipment maintenance (touch-up painting, lubrication, etc.) will be performed outside the clean area. The equipment will be verified to be visibly clean before being returned to the clean area.

4.3.3 Paper Products/Untreated Wood

All paper products *not* necessary for the current work should be excluded from the area. All paper products required should be bound in notebooks, binders, etc., to minimize particle generation. Carbons or carbon copies are prohibited due to outgassing.

Cardboard and/or any untreated wood is *not* permitted under any circumstance. Particle generating products such as pencils, erasers, natural fiber ropes, etc., are *not* allowed during staging of flight hardware.

4.3.4 Metal/Particle Generation

The use of metal abrading tools such as pipe wrenches, pliers, vise grips, etc., shall be minimized and adequate precautions in place during use. Particle generating activities such as sanding, drilling, grinding, etc., shall be minimized whenever possible. Adequate precautions such as continuous vacuuming, use of tents, laminar flow benches, etc., shall be used whenever possible to reduce particle generation.

Scissors and/or a knife shall be used when opening protective covers or bags. The bags should *not* be ripped open. Non-wheeled furniture and support equipment shall be clean room approved or equivalent and should be lifted from the floor during moves.

Rust on any items within the fueling high bays shall be removed and the affected surface re-treated.

4.3.5 Facility Crane and Rollup Doors

The facility crane hook or the spacecraft lifting assembly will be fitted with a debris shield or plastic covering to collect oil drippings, wire rope filings, etc. The crane will be inspected and the rail systems vacuumed annually.

The clean room area cranes and rollup doors will be fitted with absorbent pads to reduce the potential for oil drippings from lubricated parts.

4.3.6 Trash Containers/Mopping

The area trash containers will be emptied each normal scheduled work day whenever spacecraft hardware is present. The air lock, garment, high bay, and encapsulation bay floors will be dry and/or damp mopped according to the user schedule. The air lock will be dry mopped after opening the doors to the outside environment and the air lock particulate reestablished before the interior door is opened. Damp mopping will be performed when operational activities are at a minimum and after verifying that thermal constraints will *not* be compromised.

4.3.7 Spacecraft Processing Ground Support Equipment (GSE)

Spacecraft processing Ground Support Equipment (GSE), which is not visually clean, will undergo an IPA/H_2O wipe before being taken into the controlled area. Spacecraft shipping container will be pressure washed outside the air lock if excessive dust is evident. The container will be wiped to remove excessive moisture and then be wiped with IPA/H2O after entry into the air lock.

4.3.8 Garment Change Rooms

The garment change rooms are utilized to control the contaminants brought into the controlled areas by personnel. Personnel are to dislodge debris from shoes by using a shoe cleaner either outside or in the garment room and/or by using tacky mats (if applicable).

Personnel will don the appropriate outer clean room garment (Tyvek or equivalent smocks at a minimum) and cleanroom shoes or shoe coverings if applicable in the garment change room. If applicable, hair (bouffants at a minimum) and beard coverings will also be donned in the garment change room. The hair coverings will be stored in clean plastic receptacles mounted on the garment room wall. Once suited, personnel will walk through an air shower (ionized or air flow). The air showers are typically *not* activated unless requested by the user.

Upon exiting the clean areas, the shoe and head coverings will be removed and disposed of in the trash receptacles. The clean room garments will be properly stored.

The tops of the garment lockers will be kept clear of debris and will undergo an IPA/water wipe by janitorial personnel at least once per week. The garment room floor will be kept free of debris and will be damp mopped at least once per week.

4.3.9 Air Lock/Encapsulation Bay

The air lock is the area in which shipping containers is initially received and the equipment is unpackaged. Spacecraft shipping container exteriors are usually cleaned and remain in the airlock during removal of the spacecraft. Most GSE shipping containers are removed from the air lock after the GSE is unpackaged. Once unpackaged, all GSE equipment is visually inspected, wiped, and allowed to thermally stabilize before it is readied for movement into the processing high bay. The room provides large access doors to the processing bay and the outside to accommodate sizable equipment transfer.

Clean room garments are *not* to be worn in the air lock when the external door is open. If the door operator must enter through a clean area, the clean room garments worn into the air lock shall be removed and bagged before opening the external air lock door. Street clothes are to be worn in the air lock until after the external door has been closed and final cleaning/equipment removal has been completed. Personnel who accessed into the air lock via a clean area and removed and bagged their garments are to remain in street clothes and exit the air lock with their bagged garments through the emergency exit door.

The area will usually require that either tacky mats be pre-positioned or that a dry and wet mop be performed after delivery truck offload. Once the exterior air lock door is closed, the air lock will attain Class 100,000 within 30 to 45 minutes of door closure. The cleanliness will be verified before any clean area door is opened.

If the air lock to high bay door is to remain open for extended periods, the air lock will become part of the clean area and the external air lock door will *not* be opened. All applicable high bay cleaning and entry procedures will then be imposed for the air lock.

The encapsulation bay is the area in which launch vehicle equipment is initially received and removed from exterior delivery containers. The hardware is usually protected within the containers by bagging to preserve cleanliness of the hardware. Once the shipping containers are removed from the area, the walls (10 foot and down) are wiped and the floors are mopped or scrubbed to establish clean rooms conditions. The hardware is then unbagged, visually inspected, wiped, and readied for processing. The

room is then maintained as a clean area until the hardware is ready to be transported from the facility. Once ready for transport, a gaseous nitrogen or conditioned air purge is usually initiated within the encapsulated container to maintain flight hardware cleanliness whenever the exterior door is open to position transport vehicles or other items in the encapsulation bay.

4.3.10 Clean Areas/High Bay

The high bay is the clean room area where all spacecraft processing activity will occur. The area rollup door will only be opened after the adjoining area (usually the air lock) is verified to be at the Class 100,000 level. The high bay will be cleaned and clean room conditions verified at a minimum of 24 hours prior to occupancy by the user. The areas will be dry mopped and/or vacuumed using a HEPA filtered vacuum (or a vacuum that exhausts outside of the clean area) a minimum of once per normal work day unless the user requests a different schedule. The area will be damp mopped a minimum of once per week. The cleaning schedule and method as well as personnel limits shall be modified as appropriate to maintain Class 100,000 cleanliness.

4.3.11 Control Rooms

The control room is the area where spacecraft electrical hardware and personnel are stationed during most of the spacecraft functional checkout. The Heating, Ventilation, and Air Conditioning (HVAC) system for most control rooms are designed to provide thermal conditioning but does *not* contain HEPA filters. Use of equipment access doors between the controlled rooms and the high bay (if applicable) should *not* be utilized to routinely move equipment into and out of the high bay. If utilized the personnel entry door to the control room must be closed before the access doors are opened. The access doors shall remain open only for the time required to place the equipment into the high bay. Personnel shall *not* enter into the high bay without donning the appropriate clean area garments.

4.4 MONITORING/DATA RECORDINGS

Even though more than the required 0.5 and 5.0 micron range may be monitored by facility devices, the 0.5 micron size limit of 100,000 particles and the 5.0 micron size limit of 700 particles are to be utilized as the Class 100,000 cleanliness limits. As a minimum, the unit will be set to alarm if the reading exceeds the 100,000 particles 0.5 micron or larger limit.

Particulate and thermal condition monitoring shall begin 24 hours before payload arrival and continue through processing. The user will establish the frequency at which the cleanliness level is determined and recorded. The standard guideline minimum is every four hours upon initial monitoring and then every eight hours after the initial two days. The customer typically provides and programs their own unit to cover frequent and/or exposure critical sampling.

The facility temperature and humidity readings are collected and historical trends established by a computer-based collection system. Preset verification conditions are established during processing periods to alert personnel to system failures and anomalies. Printouts can be made available if requested by the user. A temperature/humidity recorder will be located in the processing areas to provide operating personnel with a visual indication of high bay conditions. The location, time, date, program name, etc., will be recorded on the temperature/humidity recorder chart for historical reference. The temperature/humidity recorder will be calibrated in accordance with the manufacturer's recommendation.

4.4.1 Sampling Equipment

Airborne particle monitoring shall be accomplished by a particle counter placed on the room air intake side of the processing high bay. The particle counter will have been calibrated within the year.

4.4.2 Non-Volatile Residue (NVR)

NVR is *not* typically measured as part of maintaining Class 100,000. The user may collect NVR contamination levels and is responsible for establishing the collection locations and sampling. Facility historical NVR data has been collected for some processing areas utilizing one-foot square witness collection plates, analyzed by certified laboratories in accordance with American Society for Testing and Materials (ASTM) procedures. The historical data is available as a baseline guide for subsequent missions.

4.4.3 Hydrocarbons

Hydrocarbons are *not* typically measured as part of maintaining Class 100,000. The user may collect hydrocarbon contamination levels and is responsible for establishing the collection locations and sampling. Facility historical hydrocarbon data has been collected for some of the areas utilizing certified and calibrated hydrocarbon monitoring equipment. The historical data is available as a baseline guide for subsequent missions.

APPENDIX A, CLEAN ROOM USE RESTRICTED ITEMS

MATERIAL	USE	REMARKS/LIMITATIONS
ABRASIVES (Emery cloth, sandpaper, scotch-brite pads, etc.)	Contingency repair only.	Use approved emergency clean-up procedures.
CONTAINERS (Glass beakers, bottles, test tubes, etc.)		Must have protective cover that will contain fragments in case of breakage.
CORROSIVE MATERIALS (Alodine, Sulfuric Acid, etc.)	Approved procedures only.	Containers must be labeled with contents and appropriate health and safety warnings. Limited quantities in shatterproof containers.
Electrical extension cords		Connections *not* permitted during use of flammable liquids.
FLAMMABLE LIQUIDS AND PRIMERS (Epoxy, ethyl alcohol, isopropyl alcohol, paint, primer, etc.)	Approved procedures only.	Containers must be labeled with contents and appropriate health and safety warnings. Limited quantities in shatterproof containers. Electrical connections should *not* be made or broken during use. Do *not* use in vicinity of heat source.
HEAT PRODUCING EQUIPMENT (Brazing, heaters, heat gun, heat lamp, soldering iron, etc.)	Approved procedures only.	Must be attended at all times. *Not* to be used when flammables are exposed. Heat restricted to approved work areas – adjacent area must be protected from damage.
PROPELLANT FUELS and OXIDIZERS	Sampling and fueling only.	Propellant will be staged in cart rooms until needed.
RTV Adhesive, duct tape		May be restricted by the user and must *not* come in contact with Spacecraft (S/C).
TOOLS (Compressed Air Operated)		Air discharge must be routed to area free and clear of contamination critical hardware.
WOOD		Exposed surface must be painted or sealed.

APPENDIX B, CLEAN ROOM PROHIBITED MATERIALS

AEROSOL MATERIALS
ABRASIVES (Aluminum or steel wool, wire brush, staplers, etc.)
ASBESTOS
GLASS or SHATTERABLE MATERIAL, UNPROTECTED
MERCURY
OIL
SHEDDING MATERIALS (Natural fiber rope, string, pencils, erasers)
WOOD (Unprotected raw, cardboard, particleboard, etc.)